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The Technical Communication Practices of Russian and U.S. Aerospace Engineers and Scientists

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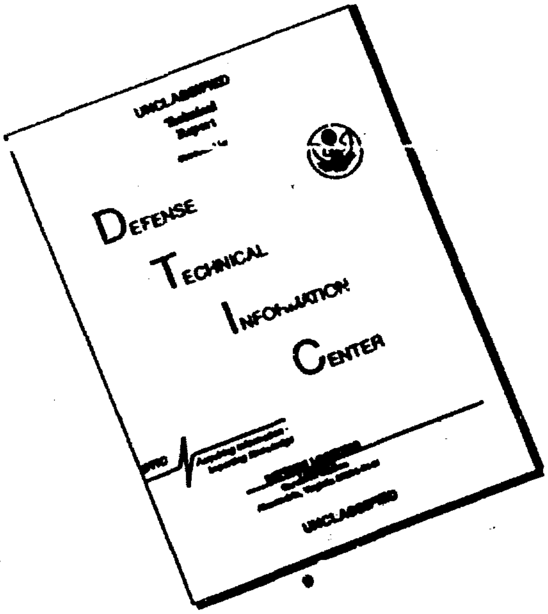

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The Technical Communication Practices of Russian and U.S. Aerospace Engineers and Scientists

Thomas E. Pinelli, Rebecca O. Barclay, Michael L. Keene, Madelyn Flammia, and John M. Kennedy

Abstract— **As part of Phase 4 of the NASA/DoD Aerospace Knowledge Diffusion Research Project, two studies were conducted that investigated the technical communication practices of Russian and U.S. aerospace engineers and scientists. Both studies had the same five objectives: first, to solicit the opinions of aerospace engineers and scientists regarding the importance of technical communication to their professions; second, to determine the use and production of technical communication by aerospace engineers and scientists; third, to seek their views about the appropriate content of the undergraduate course in technical communication; fourth, to determine aerospace engineers' and scientists' use of libraries, technical information centers, and on-line databases; and fifth, to determine the use and importance of computer and information technology to them. A self-administered questionnaire was distributed to Russian aerospace engineers and scientists at the Central Aero-Hydrodynamic Institute (TsAGI) and to their U.S. counterparts at the NASA Ames Research Center and the NASA Langley Research Center. The completion rates for the Russian and U.S. surveys were 64 and 61%, respectively. Responses of the Russian and U.S. participants to selected questions are presented in this paper.**

INTRODUCTION

Emerging patterns of multinational cooperation and collaboration in various industries, growing recognition of the importance of global economic factors, and revolutionary changes in computer and communications technology are combining to influence and transform the international communication of scientific and technical information (STI). Nowhere is this transformation more apparent than in aerospace, an industry which is becoming more international in scope and increasingly collaborative in nature. STI is recognized as an essential part of aerospace research and development. In fact, studies indicate that timely access to STI can increase productivity and innovation and help aerospace engineers and scientists maintain and improve their professional skills.

Little is known, however, about how aerospace engineers and scientists find and use STI, or about how aerospace knowledge is diffused in general. To learn more about this process, researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, Rensselaer Polytechnic Institute, and institutions in selected countries are studying aerospace knowledge diffusion under the aegis of the NASA/DoD Aerospace Knowledge Diffusion Research Project [1]. To contribute to the understanding of workplace culture, organization, and communications at the national and international levels, this article presents results of the project's most recent undertaking, a study of the views of aerospace engineers and scientists at three similar research organizations in Russia and the United States (U.S.).

Phase 1 of the larger project investigates the information-seeking behavior of U.S. aerospace engineers and scientists, with particular emphasis on their use of federally funded aerospace research and development and of U.S. government technical reports. Phase 2 examines the industry-government interface and emphasizes the role of information intermediaries in the aerospace knowledge diffusion process. Phase 3 concerns the academic-government interface and focuses on the relationships between and among the information intermediary, faculty, and students. Phase 4, of which the current study is a part, explores patterns of technical communication among non-U.S. aerospace engineers and scientists in selected countries. Thus far we have completed studies of technical communication practices among aerospace engineers and scientists in Israel [2], Japan [3], and selected western European countries [4]. The Russian/U.S. study reported on here included the following objectives:

1) To solicit t' : opinions of aerospace engineers and scientists regarding the importance of technical communication to their profession,
2) To determine the use and production of technical communications by aerospace engineers and scientists,
3) To seek their views about the appropriate content of an undergraduate course in technical communication,
4) To determine their use of libraries and technical information centers, and
5) To determine the use and importance of computer and information technology to them.

RESEARCH DESIGN AND METHODOLOGY

This research was conducted at three comparable aeronautical research facilities: the Central Aero-Hydrodynamic Institute (TsAGI), the NASA Ames Research Center, and the NASA Langley Research Center, using self-administered mail surveys. The instrument used to collect the data had been used previously in several western European countries and Japan and was adapted for use in Russia. Russian-language questionnaires were distributed to 325 researchers at TsAGI. By the established cut-off date, 209 were received, for a completion rate of 64%. English-language questionnaires were also distributed to 558 researchers at the two NASA installations. By the established cut-off date, 340 were received, for a

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TABLE 1
DEMOGRAPHIC FINDINGS

	Russia		U.S.	
	%	(n)	%	(n)
Professional Duties				
Design/development	13	(27)	6	(21)
Administration/management	2	(5)	11	(37)
Research	77	(160)	82	(279)
Other	8	(17)	1	(3)
Organizational Affiliation				
Government	100	(209)	100	(340)
Professional Work Experience				
1 - 5 years	4	(9)	15	(52)
6 - 10 years	22	(46)	22	(74)
11 - 20 years	34	(71)	28	(95)
21 - 40 years	37	(77)	34	(115)
41 or more years	3	(6)	1	(4)
Russia / U.S.				
Mean 20 / 17				
Median 17 / 14				
Education				
Bachelor's degree or less	53	(110)	27	(91)
Graduate degree	47	(99)	73	(249)
Educational Preparation				
Engineer	79	(164)	80	(273)
Scientist	21	(45)	17	(58)
Other	0	(0)	3	(9)
Current Duties				
Engineer	31	(65)	69	(234)
Scientist	68	(142)	27	(92)
Other	1	(2)	4	(14)
Member of a Professional/ Technical Society	22	(46)	78	(265)
Gender				
Female	15	(32)	15	(50)
Male	85	(177)	85	(290)

completion rate of 61%. The survey at TsAGI was conducted during April and May of 1992, and the surveys at the NASA centers were conducted during July and August of 1992.

PRESENTATION OF THE DATA

This article presents selected results from the Russian and U.S. studies, with Russian responses presented first. The presentation begins with demographic data, followed by data dealing with the importance of technical communication, workplace use, production of technical communications, and appropriate course content for an undergraduate course in technical communication.

Demographic Information About The Survey Respondents

Survey respondents were asked to provide information regarding their professional duties, years of professional work experience, educational preparation, current professional duties, and gender. These demographic findings appear in Table 1. A comparison of the two groups reveals some differences and some similarities. The two groups differ significantly in education, current duties, and professional/technical society membership; they are similar in years of professional work experience, organizational affiliation, educational preparation, and gender.

The following "composite" participant profiles were based on these data. The Russian survey participant

TABLE 2
MEAN (MEDIAN) NUMBER OF HOURS SPENT EACH WEEK BY RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS COMMUNICATING TECHNICAL INFORMATION

	Russia	U.S.
Communication with Others	8.75 (7.00) hours/week	16.95 (15.0) hours/week
Working with Communications Received from Others	7.64 (6.00) hours/week	13.97 (12.0) hours/week
Percent of Work Week Devoted to Technical Communications*	41%	77%

* Based on a 40-hour work week

- works as a researcher (77%),
- has a bachelor's degree (53%),
- trained as an engineer (79%) but currently works as a scientist (68%), and
- has an average of 20 years of professional work experience.

The U.S. survey participant

- works as a researcher (82%),
- has a graduate degree (73%),
- trained as an engineer (80%) and currently works as an engineer (69%),
- has an average of 17 years of professional work experience, and
- belongs to a professional/technical society (78%).

Importance of and Time Spent on Technical Communications

Approximately 89% of the Russian respondents and 91% of the U.S. respondents indicated that the ability to communicate technical information effectively is important. (Importance was measured on a 5-point scale, with 1 = very unimportant and 5 = very important; percentages reported here were "4" and "5" responses combined.) While Russian aerospace engineers and scientists spend an average of 8.75 hours per week communicating technical information to others, U.S. aerospace engineers and scientists spend an average of 16.95 hours per week (almost twice as much). Similarly, while Russian aerospace engineers and scientists spend an average of 7.64 hours per week working with communications received from others, U.S. aerospace engineers and scientists spend an average of 13.97 hours per week (again almost twice as much) (see Table 2).

Considering both the time spent communicating with others and the time spent working with communications received from others, technical communication takes up approximately 41% of the Russian aerospace engineer's and scientist's 40-hour work week and 77% of the U.S. aerospace engineer's and scientist's work week: the U.S. respondents report spending almost twice as much time in these information-related activities.

Approximately 30% of the Russian respondents and 70% of the U.S. respondents indicated that the amount of time they spend communicating technical information has increased over the past five years (see Table 3). 41% of the Russian respondents and 24% of the U.S. respondents indicated that

TABLE 3
CHANGES IN THE PAST FIVE YEARS IN THE AMOUNT OF TIME SPENT COMMUNICATING TECHNICAL INFORMATION BY RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Russia		U.S.	
	%	(n)	%	(n)
Increased	30	(63)	70	(239)
Stayed the Same	41	(85)	24	(80)
Decreased	29	(61)	6	(6)

TABLE 4
CHANGES IN THE AMOUNT OF TIME SPENT COMMUNICATING TECHNICAL INFORMATION AS A PART OF PROFESSIONAL ADVANCEMENT BY RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Russia		U.S.	
	%	(n)	%	(n)
Increased	38	(80)	65	(221)
Stayed the Same	45	(94)	26	(37)
Decreased	17	(35)	9	(32)

TABLE 5
COLLABORATIVE WRITING PRACTICES OF RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Russia		U.S.	
	*%	(n)	*%	(n)
I Write Alone	7	(14)	15	(50)
I Write With One Other Person	69	(145)	72	(246)
I Write With a Group of 2 to 5 Persons	83	(174)	61	(208)
I Write With a Group of More Than 5 Persons	20	(42)	14	(47)

* Percentages do not total 100

TABLE 6
INFLUENCE OF GROUP PARTICIPATION ON WRITING PRODUCTIVITY FOR RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Russia		U.S.	
	%	(n)	%	(n)
A Group Is More Productive Than Writing Alone	8	(17)	33	(110)
A Group Is About As Productive As Writing Alone	41	(86)	32	(107)
A Group Is Less Productive Than Writing Alone	44	(92)	20	(68)
I Only Write Alone	7	(14)	15	(50)

TABLE 7
PRODUCTION OF WRITTEN TECHNICAL COMMUNICATIONS AS A FUNCTION OF NUMBER OF GROUPS AND GROUP SIZE FOR RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Russia		U.S.	
	%	(n)	%	(n)
Worked With Same Group				
Yes	50	(105)	47	(161)
No	43	(90)	40	(129)
I Only Write Alone	7	(14)	15	(50)
Number of People in Group				
Mean	3.39	(105)	3.21	(161)
Median	3.00	(105)	3.00	(161)
Number of Groups				
Mean	2.82	(90)	2.82	(129)
Median	2.00	(90)	3.00	(129)
Number of People in Each Group				
Mean	3.38	(90)	3.03	(129)
Median	3.00	(90)	3.00	(129)

the amount of time they spend communicating technical information has stayed the same over the past five years. 29% of the Russian respondents and 6% of the U.S. respondents indicated that the amount of time they spend communicating technical information has decreased over the past five years.

As they have advanced professionally, 38% of the Russian respondents have increased the amount of time they spend communicating technical information. Likewise, 65% of the U.S. respondents indicated that they have increased the amount of time they spend communicating technical information as they have advanced professionally (see Table 4).

Production and Use of Technical Communication

Collaborative Writing: Survey participants were asked whether they wrote alone or as part of a group (see Table 5). Only 7% of the Russian respondents and 15% of the U.S. respondents write alone. Although a higher percentage of Russian than U.S. respondents writes with a group of two to five or more persons, writing appears to be a collaborative process for both Russian and U.S. respondents.

Russian and U.S. aerospace engineers and scientists were asked to assess the influence of group participation on writing productivity (see Table 6). Only 8% of the Russian respondents and 33% of the U.S. respondents indicated that group writing is more productive than writing alone. 41% of the Russian respondents and 32% of the U.S. respondents found that group writing is about as productive as writing alone, and 44% of the Russian respondents and 20% of the U.S. respondents found that writing in a group is less productive than writing alone.

Of those respondents who do not write alone, 50% of the Russian aerospace engineers and scientists (compared to 47% of the U.S.) work with the same group when producing written technical communication (see Table 7). The average number of people in the Russian group was 3.39, and the average number in the U.S. group was 3.21. 43% of the Russian respondents work in an average (mean) number of 2.82 groups, with each group containing an average of 3.38 people. 38% of the U.S. respondents work in an average (mean) number of 2.82 groups, with each group containing an average of 3.03 people.

Categories of Information Produced and Used: From a prepared list, both groups were asked to indicate the number of times they had prepared, either alone or as a member of a group, specific categories of technical information products during the last six months. As single authors, Russian respondents most frequently prepare drawings/specifications, memoranda, letters, abstracts, and computer program documentation (see Table 8). When working in groups, Russian aerospace engineers and scientists reported most frequently preparing drawings/specifications, audio/visual materials, letters, trade/promotional literature, and computer program documentation. For these products, the mean number of persons per group ranged from a high of 3.10 to a low of 2.00.

As single authors, U.S. respondents reported preparing memoranda, letters, drawings/specifications, audio/visual materials, and technical talks/presentations most frequently during the last six months (see Table 9). When working in groups, U.S. aerospace engineers and scientists prepare letters,

TABLE 8

MEAN (MEDIAN) NUMBER OF TECHNICAL INFORMATION PRODUCTS PRODUCED IN THE PAST SIX MONTHS BY RUSSIAN AEROSPACE ENGINEERS AND SCIENTISTS

	Alone		In a Group		Average Number of Persons Per Group	
	Mean	Median	Mean	Median	Mean	Median
Abstracts	6.13	(2.00)	1.82	(1.50)	2.61	(2.00)
Journal Articles	1.43	(1.00)	1.48	(1.00)	2.55	(2.00)
Conference/Meeting Papers	2.00	(1.00)	1.53	(1.00)	2.96	(2.00)
Trade/Promotional Literature	0.00	(0.00)	3.00	(1.00)	3.00	(3.00)
Drawings/Specifications	8.29	(5.00)	12.40	(2.00)	3.10	(2.00)
Audio/Visual Material	1.50	(1.50)	4.43	(1.00)	2.71	(2.00)
Letters	6.24	(5.00)	3.82	(2.00)	2.86	(2.00)
Memoranda	6.46	(3.00)	2.40	(2.50)	2.20	(2.00)
Technical Proposals	3.03	(2.00)	2.02	(2.00)	3.81	(3.00)
Technical Manuals	1.67	(1.00)	1.60	(1.00)	2.67	(2.00)
Computer Program Documentation	5.73	(2.00)	2.83	(1.50)	2.50	(2.00)
In-house Technical Reports	2.76	(2.00)	2.71	(2.00)	3.65	(3.00)
Technical Talks/Presentations	1.70	(1.00)	1.54	(1.00)	2.52	(2.00)

TABLE 9

MEAN (MEDIAN) NUMBER OF TECHNICAL INFORMATION PRODUCTS PRODUCED IN THE PAST SIX MONTHS BY U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Alone		In a Group		Average Number of Persons Per Group	
	Mean	Median	Mean	Median	Mean	Median
Abstracts	1.67	(1.00)	1.81	(1.00)	2.67	(2.00)
Journal Articles	1.33	(1.00)	1.75	(1.00)	2.74	(2.00)
Conference/Meeting Papers	1.90	(1.00)	1.54	(1.00)	2.79	(3.00)
Trade/Promotional Literature	2.00	(1.00)	1.00	(1.00)	2.50	(2.50)
Drawings/Specifications	7.21	(3.00)	3.83	(3.00)	3.02	(2.00)
Audio/Visual Material	5.73	(4.00)	5.82	(2.00)	2.95	(2.00)
Letters	9.96	(6.00)	5.95	(3.00)	2.32	(2.00)
Memoranda	16.06	(9.00)	5.14	(3.50)	2.55	(2.00)
Technical Proposals	2.17	(2.00)	2.64	(1.50)	2.61	(2.00)
Technical Manuals	2.11	(1.00)	2.11	(1.00)	3.11	(3.00)
Computer Program Documentation	3.43	(2.00)	2.20	(1.50)	2.35	(2.00)
In-house Technical Reports	2.34	(2.00)	1.80	(1.00)	2.87	(2.00)
Technical Talks/Presentations	3.54	(2.00)	3.07	(2.00)	3.46	(3.00)

audio/visual materials, memoranda, drawings/specifications, and technical talks/presentations most frequently. For these products, the mean number of persons per group ranged from a high of 3.50 to a low of 2.00.

Russian aerospace engineers and scientists reported that the categories of technical information products they use most frequently are journal articles, abstracts, letters, memoranda, and computer program documentation (see Table 10). On average, they use 18 journal articles, 16 abstracts, 13 letters, 10 memoranda, and 9 computer program documentation products in a six-month period. Audio/visual materials, technical proposals, trade/promotional literature, technical talks/presentations, and technical manuals are the technical information products used least frequently by Russian aerospace engineers and scientists during a six-month period.

U.S. aerospace engineers and scientists reported that memoranda, letters, journal articles, abstracts, and drawings/specifications are the technical information products they use most frequently. On average, they use 25 memoranda, 17 letters, 16 journal articles, 16 abstracts, and 15 drawings/specifications during a six-month period. Technical proposals, in-house technical reports, technical manuals, technical talks/presentations, and trade/promotional literature are used least frequently by U.S. aerospace engineers and scientists during a six-month period.

TABLE 10

MEAN (MEDIAN) NUMBER OF TECHNICAL INFORMATION PRODUCTS USED IN THE PAST SIX MONTHS BY RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Russia		U.S.	
	Mean	Median	Mean	Median
Abstracts	16.48	(6.00)	16.45	(10.00)
Journal Articles	18.33	(7.50)	16.54	(10.00)
Conference/Meeting Papers	6.71	(3.00)	12.00	(10.00)
Trade/Promotional Literature	4.97	(2.00)	11.77	(6.00)
Drawings/Specifications	6.63	(5.00)	15.48	(5.00)
Audio/Visual Material	2.66	(2.00)	14.59	(5.00)
Letters	13.11	(8.00)	17.28	(9.00)
Memoranda	10.12	(5.50)	25.44	(10.00)
Technical Proposals	4.41	(3.00)	5.89	(2.00)
Technical Manuals	5.26	(3.00)	7.65	(5.00)
Computer Program Documentation	9.61	(5.00)	14.57	(5.00)
In-house Technical Reports	8.61	(5.00)	6.93	(5.00)
Technical Talks/Presentations	5.08	(3.00)	10.25	(6.00)

TABLE 11

TYPES OF INFORMATION PRODUCED BY RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS [N=209; 340]

	Russia %	U.S. %
Basic Scientific and Technical Information	87	97
Experimental Techniques	51	82
Codes of Standards and Practices	44	36
Computer Programs	63	89
In-house Technical Data	80	90
Product and Performance Characteristics	43	63
Economic Information	27	19
Technical Specifications	33	69
Patents and Inventions	38	12

Types of Information Products Produced and Used: The types of technical information produced most frequently by Russian aerospace engineers and scientists include in-house technical data, computer programs, basic scientific and technical information, experimental techniques, and codes of standards and practices (see Table 11). The types of technical information produced least frequently by Russian aerospace engineers and scientists include economic information, technical specifications, and patents and inventions. U.S. aerospace engineers and scientists produce most frequently basic scientific and technical information, in-house technical data, computer programs, experimental techniques, and technical specifications. Codes of standards and practices, patents and inventions, and economic information are the types of technical information produced least frequently by U.S. aerospace engineers and scientists.

The types of technical information used most frequently by Russian aerospace engineers and scientists include basic scientific and technical information, in-house technical data, computer programs, experimental techniques, and patents and inventions (see Table 12). The types of technical information used least frequently by Russian aerospace engineers and scientists include economic information, technical specifications, and patents and inventions. U.S. aerospace engineers and scientists most frequently use basic scientific and technical information, in-house technical data, computer programs, experimental techniques, and technical specifications. Patents and inventions, economic information, and codes of standards and practices are the types of technical information used least frequently by U.S. aerospace engineers and scientists.

TABLE 12
TYPES OF INFORMATION USED BY RUSSIAN AND U.S.
AEROSPACE ENGINEERS AND SCIENTISTS [N=209; 340]

	Russia %	U.S. %
Basic Scientific and Technical Information	48	92
Experimental Techniques	46	65
Codes of Standards and Practices	19	9
Computer Programs	56	61
In-house Technical Data	83	86
Product and Performance Characteristics	29	32
Economic Information	27	19
Technical Specifications	23	45
Patents and Inventions	31	25

TABLE 13
INFORMATION SOURCES USED BY RUSSIAN AND U.S.
AEROSPACE ENGINEERS AND SCIENTISTS IN PROBLEM SOLVING

	Russia		U.S.	
	%	(n)	%	(n)
Personal Store of Technical Information	51	(106)	99	(373)
Spoke With a Co-worker or People Inside My Organization	90	(187)	98	(371)
Spoke With Colleague Outside of My Organization	36	(75)	93	(318)
Used Literature Resources Found in My Organization's Library	85	(178)	91	(310)
Spoke With a Librarian or Technical Information Specialist	59	(123)	80	(214)

From a list of information sources, survey participants were also asked to indicate which sources they routinely use in problem solving (see Table 13). The information-seeking behavior of the Russian participants varied from that of their American counterparts. The Russian aeronautical engineers and scientists speak with co-workers in the organization, use literature resources found in the organization's library, speak with a librarian or technical information specialist, use their personal stores of technical information, and speak with a colleague outside the organization. In addition to personal knowledge, upon which they rely greatly, the U.S. aerospace engineers and scientists in this study display information-seeking behavior patterns similar to those of U.S. engineers in general. U.S. participants use their personal store of technical information, co-workers in the organization, colleagues outside the organization, literature resources found in the organization's library, and a librarian or technical information specialist.

Content for an Undergraduate Course in Technical Communication

Russian and U.S. survey participants were asked their opinions regarding an undergraduate course in technical communication for aerospace majors. Approximately 25% of the Russian respondents and 71% of the U.S. respondents indicated that they had taken a course or courses in technical communication. Approximately 11% of the Russian participants had taken coursework as undergraduates, approximately 7% had taken coursework after graduation, and about 7% had taken courses both as undergraduates and after graduation. Approximately 20% of the U.S. respondents had taken

TABLE 14
OPINIONS REGARDING AN UNDERGRADUATE COURSE IN
TECHNICAL COMMUNICATION FOR AEROSPACE MAJORS

	Russia		U.S.	
	%	(n)	%	(n)
Taken for Credit	18	(37)	80	(269)
Not Taken for Credit	30	(63)	7	(23)
Don't Know	15	(31)	4	(15)
Should Not Have to Take a Course in Technical Communications	37	(78)	10	(33)

coursework as undergraduates, approximately 19% had taken coursework after graduation, and 32% had taken courses both as undergraduates and after graduation.

Of the 25% (52 respondents) of the Russian engineers and scientists who had taken coursework in technical communication, about 23% (49 respondents) indicated that doing so has helped them to communicate technical information. Of the 70% (241 respondents) of the U.S. engineers and scientists who had taken coursework in technical communications/writing, about 67% (233 respondents) indicated that doing so has helped them to communicate technical information.

Russian and U.S. participants were asked their opinions regarding the desirability of undergraduate aerospace majors taking a course in technical communication. Approximately 63% of the Russian respondents and 90% of the U.S. participants indicated that aerospace majors should take such a course. Approximately 18% of the Russian participants and about 80% of the U.S. participants indicated that the course should be taken for credit (see Table 14).

The Russian participants were asked if (1) undergraduate aerospace engineering and science majors should take a course in technical communication, and if so, (2) how the course should be offered. About 63% (131 respondents) of the Russian participants indicated "yes," students should take a course in technical communication. About 16% of the Russian respondents indicated that the course should be taken as part of a required course; about 24% thought the course should be taken as part of an elective course; about 18% thought it should be taken as a separate course; about 5% did not have an opinion; and 37% of the Russian respondents indicated that undergraduate aerospace engineering and science students should not have to take a course in technical communication.

Russian and U.S. respondents were asked to select, from similar lists, the appropriate principles for inclusion in an undergraduate technical communication course for aerospace engineering and science students. Table 15 shows their responses. The Russian respondents indicated that matters of correctness, such as style and form of publications, word choice, note-taking, and quoting, are more important than process-oriented concerns, such as organizing information, defining purpose, and assessing readers' needs, concerns which are typically stressed in U.S. undergraduate writing courses. The U.S. respondents, on the other hand, selected the holistic concerns of organizing information, defining the communication's purpose, and assessing readers' needs over those principles that deal more specifically with matters of correctness, although

TABLE 15
RECOMMENDED PRINCIPLES FOR AN UNDERGRADUATE TECHNICAL COMMUNICATION COURSE FOR AEROSPACE MAJORS

Principles	Russian* %	Russian* (n)	U.S. %	U.S. (n)
Organizing Information	40	(84)	97	(329)
Defining the Communication's Purpose	39	(82)	91	(310)
Developing Paragraphs	48	(101)	87	(296)
Assessing Reader's Needs	35	(74)	87	(295)
Choosing Words	49	(102)	83	(283)
Note Taking and Quoting	43	(90)	44	(149)
Editing and Revising	37	(77)	87	(295)
Style/Form of Publications	52	(108)	**	**

* About 37% of the 209 Russian participants indicated that undergraduate aerospace engineering and science majors should not have to take a technical communications course.

** Not asked of U.S. participants

TABLE 16
RECOMMENDED MECHANICS FOR AN UNDERGRADUATE TECHNICAL COMMUNICATION COURSE FOR AEROSPACE MAJORS

Mechanics	Russian* %	Russian* (n)	U.S. %	U.S. (n)
References	47	(99)	80	(272)
Symbols	38	(80)	64	(218)
Punctuation	22	(46)	74	(251)
Spelling	23	(48)	55	(187)
Abbreviations	44	(91)	55	(187)
Numbers	27	(56)	48	(163)
Capitalization	24	(51)	54	(182)
Acronyms	27	(56)	52	(176)
Relations Between Different Systems of Measurement	36	76	**	**

* About 37% (78) of the 209 Russian participants indicated that undergraduate aerospace engineering and science majors should not have to take a technical communications course.

** Not asked of U.S. participants

both groups of respondents did select developing paragraphs as one of the top five principles for inclusion.

Russian and U.S. respondents also chose, from a list of specific topics, those mechanics to be included in an undergraduate technical communication course for aerospace students. Their responses appear in Table 16. Although both groups of respondents indicated that references, abbreviations, and symbols belong in the top-five list for inclusion, the Russian respondents again focused on the accurate presentation of scientific and technical data. They also placed relations between different systems of measurement, acronyms, and numbers in the top-five list, whereas the U.S. respondents selected punctuation, capitalization, and spelling for the top-five list. Perhaps these differences are attributable to the same demographic, cultural, and institutional differences that influenced the selection of appropriate principles for inclusion in a technical communication course.

Given a list of 13 items, the Russian and U.S. respondents were next asked to select appropriate on-the-job communications to be included in an undergraduate technical communication course for aerospace students. Their responses appear in Table 17. Both groups selected journal articles, technical reports, conference/meeting papers, oral presentations, literature reviews, letters, use of information sources, and technical instructions for inclusion, although not in the same order of appearance. It is interesting to note that more similarities than differences exist among their choices for the types of written communications that students should learn to produce. These choices also probably reflect information acquisition and use patterns among aerospace professionals.

TABLE 17
RECOMMENDED ON-THE-JOB COMMUNICATIONS TO BE TAUGHT IN AN UNDERGRADUATE TECHNICAL COMMUNICATION COURSE FOR AEROSPACE MAJORS

On-the-Job Communications	Russian* %	Russian* (n)	U.S. %	U.S. (n)
Oral Technical Presentations	50	(105)	92	(311)
Abstracts	53	(110)	85	(289)
Use of Information Sources	46	(96)	72	(244)
Conference/Meeting Papers	50	(104)	67	(228)
Technical Reports	51	(106)	81	(274)
Technical Instructions	40	(84)	62	(212)
Journal Articles	57	(120)	64	(217)
Letters	47	(98)	61	(208)
Technical Specifications	36	(75)	45	(152)
Literature Reviews	48	(101)	50	(169)
Memoranda	34	(70)	60	(204)
Technical Manuals	34	(71)	43	(147)
Newsletter/Paper Articles	39	(81)	15	(50)

* About 37% (78) of the 209 Russian participants indicated that undergraduate aerospace engineering and science majors should not have to take a technical communications course

In an attempt to validate these findings, the top ten on-the-job communications were paired with the top five (on the average) technical communication products produced and used by Russian and U.S. respondents. (See Table 18.) The on-the-job communications recommended by Russian respondents do not appear to reflect closely the types of communications they produce and use; nor do the responses of the U.S. respondents appear to reflect the types of communications they produce and use. Perhaps the differences are attributable to the institutional cultures of both groups of respondents. It is interesting to note that, although neither group places technical reports in the top-five category of communications produced or used, both groups recommended that report writing be taught. Technical reports, which can be expected to yield valuable information for researchers, are often collaboratively written and are lengthy and time-consuming to produce. Additionally, they are sometimes difficult to acquire for a variety of reasons.

It would be interesting to ascertain if a relationship exists between the recommendation by both groups of respondents to teach technical report writing and information acquisition skills (use of information sources). Certainly, information acquisition skills need to be developed as an important part of effective communication in the light of an expanding international knowledge base and the array of information technology that is becoming available to many users.

Use of Libraries and Technical Information Centers

Almost all of the respondents indicated that their organization has a library or technical information center. Unlike the U.S. respondents (9%), about 45% of the Russian respondents indicated that the library or technical information center is located in the building where they work. About 53% of the

TABLE 18
COMPARISON OF RUSSIAN AND U.S. RESPONSES CONCERNING TECHNICAL INFORMATION PRODUCTS PRODUCED, USED, AND RECOMMENDED

Russian	U.S.
Produced	**Produced**
Drawings/Specifications	Memoranda
Memoranda	Letters
Letters	Drawings/Specifications
Abstracts	Audio/Visual Material
Computer Program Documentation	Technical Talks/Presentations
Used	**Used**
Journal Articles	Memoranda
Abstracts	Letters
Letters	Journal Articles
Memoranda	Abstracts
Computer Program Documentation	Drawings/Specifications
Recommended	**Recommended**
Journal Articles	Oral Presentations
Abstracts	Abstracts
Technical Reports	Technical Reports
Conference/Meeting Papers	Use of Information Sources
Oral Presentations	Conference/Meeting Papers
Literature Reviews	Journal Articles
Letters	Technical Instructions
Use of Information Sources	Letters
Technical Instructions	Memoranda
Newsletter/Paper Articles	Literature Reviews

TABLE 20
IMPORTANCE OF THE ORGANIZATION'S LIBRARY TO RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Russian		U.S.	
	%	(n)	%	(n)
Very Important	82.[illegible]	(173)	68.3	(232)
Neither Important or Unimportant	12.4	(26)	15.6	(53)
Very Unimportant	2.[illegible]	(4)	12.9	(44)
Do not have a library	2.[illegible]	(6)	3.2	(11)

TABLE 21
USE OF COMPUTER SOFTWARE BY RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS TO PREPARE WRITTEN TECHNICAL COMMUNICATIONS

	Russian		U.S.	
Software	%	(n)	%	(n)
Word Processing	72	(150)	96	(327)
Outliners and Prompters	34	(72)	14	(46)
Grammar and Style Checkers	11	(22)	30	(103)
Spelling Checkers	17	(35)	88	(299)
Thesaurus	12	(26)	37	(127)
Business Graphics	24	(50)	15	(52)
Scientific Graphics	53	(110)	91	(308)
Desktop Publishing	4	(9)	47	(162)

TABLE 19
USE OF THE ORGANIZATION'S LIBRARY IN PAST SIX MONTHS BY RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Russian		U.S.	
Visits	%	(n)	%	(n)
0 times	4	(9)	11	(37)
1 - 5 times	31	(65)	43	(145)
6 - 10 times	34	(71)	21	(73)
11 - 25 times	19	(40)	14	(49)
26 - 50 times	6	(13)	7	(22)
51 or more times	2	(5)	1	(4)
Does not have a library	3	(6)	3	(11)
Mean	12.5		9.2	
Median	10.0		4.0	

Russian and 88% of the U.S. respondents indicated that the library or technical information center is outside the building in which they work and that it is located near where they work. For about 49% of the Russians, the library or technical information center is located 1.4 kilometers or less from where they work. For about 81% of the U.S. respondents, the library or technical information center is located 1.0 mile or less from where they work.

Respondents were asked to indicate the number of times they had visited their organization's library or technical information center in the past six months (see Table 19). Overall, the Russian respondents use their organization's library or technical information center more than their U.S. counterparts do. The average use rate for Russian aerospace engineers and scientists is 12.5 during the past six months, compared to 9.2 for the U.S. aerospace engineers and scientists. The median six-month use rates for the two groups were 10.0 and 4.0, respectively.

Respondents were also asked to rate the importance of their organization's library or technical information center (see Table 20). Importance was measured on a five-point scale, with 1 = not at all important and 5 = very important. A majority of both groups indicated that their organization's library or technical information center is important to performing their present professional duties. About 83% of the Russian aerospace engineers and scientists indicated that their organization's library or technical information center is very important to performing their present professional duties. About 68% of the U.S. aerospace engineers and scientists indicated that their organization's library or technical information center is very important to performing their present professional duties. About 2% of the Russian respondents and about 13% of the U.S. respondents indicated that their organization's library or technical information center is very unimportant to performing their present professional duties.

Use and Importance of Computer and Information Technology

Survey participants were asked if they use computer technology to prepare technical information. About 83% of the Russian respondents use computer technology to prepare technical information. Almost all (98%) of the U.S. respondents use computer technology to prepare technical information. About 16% of the Russian respondents and about 73% of the U.S. respondents "always" use computer technology to prepare technical information. A majority of both groups (76% and 98%) indicated that computer technology has increased their ability to communicate technical information. About 37% of the Russian respondents and 80% of the U.S. respondents stated that computer technology has increased their ability to communicate technical information "a lot."

From a prepared list, survey respondents were asked to indicate which computer software they use to prepare written technical information (Table 21). Both groups use word processing software most frequently. With the exception of outliners and prompters and business graphics, the U.S. respondents make greater use of computer software for preparing written technical communication than do their Russian counterparts.

Survey respondents were given a list of information technologies. They were asked, "How do you view your use of the following information technologies in communicating technical information?" Their choices included "already use it;" "don't use it, but may in the future;" and "don't use it and doubt if I will." Russian and U.S. aerospace engineers and scientists use a variety of information technology. The percentages of "I already use it" responses ranged from a high of 58% (computer cassettes/cartridge tapes) to a low of 1% (laser disk/video disk/CD-ROM) for Russian respondents. Similarly, the U.S. responses ranged from a high of 91% (FAX or TELEX) to a low of 13% (audio tapes and cassettes).

Here are the information technologies used most frequently (in descending order):

Russian		U.S.	
Computer Cassettes/ Cartridge Tapes	58%	FAX or TELEX	91%
		Electronic Mail	83
		Electronic Networks	76
Micrographics and Microforms	54	Videotape	63
Electronic Databases	25	Desktop Publishing	60
FAX or TELEX	21		
Motion Picture Film	20		

Here are the information technologies not currently being used, but which may be used in the future (in descending order):

Russian		U.S.	
Electronic Networks	51%	Laser Disk/Video Disk/CD-ROM	68%
Computer Cassettes/ Cartridge Tapes	48	Video Conferencing	54
Electronic Databases	46	Electronic Bulletin Boards	48
Laser Disk/Video Disk/CD-ROM	44	Micrographics and Microforms	42
Electronic Bulletin Boards	43	Electronic Databases	40

Discussion of the Data

Prior to the dissolution of the Soviet Union, the dissemination of STI within it was strictly controlled, and communication between Russian engineers and scientists and their foreign counterparts was highly restricted [5]. Although sweeping political changes in the former Soviet Union have led to a relatively free flow of international STI, the lasting effects of the former working environment and of the corresponding Soviet information model that has prevailed since 1917 cannot be discounted [6]. Our analysis of the performance and operation of science and technology in this environment has led to the following tentative conclusions.

1. Because of a tradition of strict control exerted by the Communist Party over STI, Russian aerospace engineers and scientists can be expected to spend less time communicating STI than their U.S. counterparts spend.

Data contained in Table 2 support this. The Russian aerospace engineers and scientists in this study spend about half the time that their U.S. counterparts spend communicating with others and working with communications they receive from others. They devote only 41% of a 40-hour work week to technical communication, compared to 77% for their U.S. counterparts. Only 30% of the Russian respondents indicated that they had increased the amount of time they spend communicating STI over the past five years, whereas 70% of the U.S. respondents reported spending more time communicating STI during the same time. In fact, 29% of the Russian respondents noted a decrease in the amount of time they spend communicating technical information, compared to only 6% of the U.S. respondents.

2. Given a cultural tradition of valuing collective efforts over individual efforts, Russian aerospace engineers and scientists might be expected to emphasize the importance of collaboratively produced technical communication to a greater degree than do their U.S. counterparts. We found no evidence of this.

Writing appears to be a collaborative process for both groups of respondents. Although no statistical tests were performed, there appears to be little difference between Russian and U.S. aerospace engineers and scientists in either their collaborative writing practices (see Table 5) or their production of written technical communication as a function of the number of groups and group size. However, this lack of a real difference between the two groups in their collaborative writing practices and their production of written technical communication may well be attributable to the nature of engineering work itself. As Holmfeld [7] notes, the work requires engineers to function as teams and to share their knowledge and the results of their work with others in order to create products. It is interesting to note, however, that only 8% of the Russian respondents (compared to 33% of the U.S. respondents) indicated that group writing is more productive than writing alone; 44% of the Russian respondents (and 20% of the U.S. respondents) actually found group writing *less* productive than writing alone.

3. Given a fundamental difference between Russian and U.S. approaches to the conduct of science and technology (i.e., centralized versus decentralized), shortages of paper, and limited access to information resources, differences in the production and use of technical information products can be expected between Russian and U.S. aerospace engineers and scientists.

Data contained in Tables 8 and 9 (production) and Table 10 (use) support this tentative conclusion. Shortages of hard currency and paper, limited availability of printing and reproduction equipment, and censorship [8] would limit the ability of Russian aerospace engineers and scientists to produce documents and make presentations. The effects of information control, the low priority given to funding the acquisition of print and non-print STI, and Western nations' restrictions on the transfer of STI to former Soviet-bloc countries combine to limit the access to and acquisition and use of STI by Russian aerospace engineers and scientists. To support this tentative conclusion further, data in Table 13 suggest that technical information products are not readily available for use. When solving technical problems, Russian aerospace engineers and scientists do not rely on their personal stores of technical information (i.e., those materials kept in their offices or workplace), nor do they seek information from colleagues outside of their organizations. Instead, they seek information from co-workers and whatever literature resources are contained within their organization's library. Data contained in Table 19 show that Russian aerospace engineers and scientists do use their organization's libraries more frequently than their U.S. counterparts use libraries.

4. Russian participants selected for inclusion in an undergraduate technical communication course those principles that were product-centered (i.e., matters of form and correctness), while U.S. participants selected those that were process-centered. This difference may reflect a fundamental difference in the way writing is taught in the two countries.

It is interesting to speculate about why such differences occur. Are they attributable to demographic, institutional, or cultural differences? For example, many Russian respondents reported that they work as scientists despite having been trained as engineers, so a concern about accurate reporting of information is compatible with the communication needs of their professional community. The finding that 86% of the Russians reported that publishing in the professional literature is important for professional advancement is consistent with their need to know forms and styles of publication. Perhaps institutional or cultural differences between the two groups of respondents regarding the dissemination of information as a resource for problem solving would account for the selection of different principles which are being taught. Or perhaps Russian aerospace students are already such skilled communicators, given the very competitive nature of higher education in their country, that they have mastered the holistic concerns of composing effective written communications. Alternatively, perhaps the teaching of writing is a more subtle component of Russian aerospace curricula than our instrument could detect. If that were the case, and the teaching were more product-oriented than process-oriented, we would see the results depicted here. Is the teaching of writing (and especially technical communication) more product-centered in Russia than it is in most U.S. colleges and universities, where considerable attention has been devoted to the processes of invention and composition for the last 20 years? If so, what of the emerging U.S. emphasis on the social/theoretical aspects of writing, an emphasis based in part on the work of the Russian theorist, M. M. Bakhtin? If Soviet pedagogy missed the process revolution in composition teaching, is it also missing this later, albeit quieter, one as well?

5. Given that the former Soviet Union lagged behind the West in computer and information technology, the patterns of computer and information technology use among Russian aerospace engineers and scientists can be expected to demonstrate a similar lag.

TABLE 22
USE, NONUSE, AND POTENTIAL USE OF INFORMATION TECHNOLOGIES BY RUSSIAN AND U.S. AEROSPACE ENGINEERS AND SCIENTISTS

	Already Use It		Don't Use It but May in Future		Don't Use It and Doubt I Will	
Information Technologies	Russia %	U.S. %	Russia %	U.S. %	Russia %	U.S. %
Audio Tapes and Cassettes	12	[illegible]	22	[illegible]	34	[illegible]
Motion Picture Film	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Videotape	15	[illegible]	[illegible]	31	[illegible]	[illegible]
Desktop/Electronic Publishing	[illegible]	6	41	32	14	[illegible]
Computer Cassettes/Cartridge Tapes	[illegible]	44	[illegible]	32	[illegible]	24
Electronic Mail	2	[illegible]	[illegible]	15	11	2
Electronic Bulletin Boards	2	[illegible]	[illegible]	[illegible]	10	[illegible]
FAX or TELEX	21	91	37	[illegible]	9	1
Electronic Data Bases	25	[illegible]	46	[illegible]	6	4
Video Conferencing	2	37	31	54	33	[illegible]
Teleconferencing	2	53	26	40	32	[illegible]
Micrographics and Microforms	54	23	12	42	9	34
Laser Disk/Video Disk/CD-ROM	[illegible]	19	44	[illegible]	17	14
Electronic Networks	3	[illegible]	51	19	12	5

Data contained in Table 22 support this assumption. As a framework for discussion, the computer and information technologies contained in Table 22 may be placed into three categories: mature, maturing, and nascent. Russian aerospace engineers and scientists make greater use of the mature computer and information technologies (e.g., computer cassettes and cartridge tapes) than they do of the maturing (e.g., desktop publishing) and nascent (e.g., electronic networks) ones.

The growth of computing in the former Soviet Union has been hampered by insufficient production and support capabilities for hardware, inadequate software and peripherals development, and limited computer supplies. In addition, the poor quality of Soviet telecommunications and the inconsistency of the electrical supply system exacerbate the situation [9].

CONCLUDING REMARKS

Despite the limitations of this investigation, these findings contribute to our knowledge and understanding of the technical communication practices among aerospace engineers and scientists at the national and international levels. The primary data elicited by this kind of questionnaire-based research speak to a number of current areas of scholarly and professional interest, both within the field of technical communications and within a number of related fields—information science, engineering education, public policy, rhetoric, and composition, to name just a few. Here are five of the interesting questions our research invites practicing engineers, scientists, scholars, teachers, and R&D managers to ask:

1. How does government policy toward the flow of STI shape the technical communication practices of scientists and engineers? There is evidence in this Russian study to suggest that the tightly controlled communication practices of the former USSR had a profound effect, one that has outlasted the government that created it. While other countries may not have policies as transparently different from that of the U.S. as the Soviet Union's, there are still undoubtedly differences. As this Russian study suggests, the effects of those differences are expressed in ways an uninformed outsider might not anticipate. Knowing more about each government's policy towards the flow of STI can thus help anyone involved in international work in two ways: (1) to better anticipate possible areas of misunderstanding due to such differences, and (2) to take advantage of differences that produce vigor.

2. How do cultural differences shape the flow of STI? Beyond a government's official policies, there are the broader cultures—the language itself, the workplace, the profession, the role of work in society, and so on—that change from country to country. The ways in which they shape the flow of STI in the U.S. are becoming better and better known, but little is known in the U.S. about how other countries' cultural differences shape the flow of STI there.

3. What implications do these findings hold for those who may one day find themselves teaching people from countries such as Russia to create their own technical documents in English? Not only does the flood of non-U.S. graduate students into U.S. universities continue to grow, but today an increasing number of U.S. teachers are going to foreign countries to teach writing. Along with the many elements of second-language teaching that are already known, the differences spotlighted in this and similar studies need to be taken into account in such teaching.

4. What implications do these findings and those of similar studies have for those who find themselves working collaboratively on projects with scientists and engineers from such countries? Witness, for example, Germany's, Spain's, Italy's, and Great Britain's $34 billion joint production of a fighter aircraft, Japan's participation in the production of Boeing's 767, and the International Aero Engines (IAE) Consortium led by Rolls-Royce and Pratt and Whitney [10]. Boeing has recently proposed a "joint venture" with the Russian Central Aero-Hydrodynamic Institute (TsAGI) that could result in U.S. aerospace engineers' and scientists' working directly with their Russian counterparts. The success of the Boeing/TsAGI effort will depend, to some extent, on how effectively Russian and U.S. aerospace engineers and scientists acquire, process, and communicate STI within a collaborative framework, given a number of presumed cultural and institutional differences in their communication practices.

Finally, we close by posing three more questions that address problems inherent in international communication. How do country-by-country differences impact on the production, transfer, and use of STI and various classes of data flowing across national boundaries? What steps can be taken to facilitate communication at the individual, organizational, national, and international levels and ensure its effective management? What safeguards will countries impose on information dissemination to protect national sovereignty, and what role will information standards play in the international dissemination of information?

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